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(54) **Water purifier with means for determining filtering efficiency**

(57) A water purifier 20 comprises replaceable filters 27, 29, 31 through which water is fed from a pipe 25 into a storage tank 35. A first sensor (101) senses the purity of the water to be filtered, and a second sensor (102) senses the purity of the water after passage through the filters. The output signals from the sensors are compared electronically to produce a signal corresponding to the purifying efficiency of the filtering means. This is displayed by the display (170). One of the filters may be a reverse osmotic filter.

FIG. 5

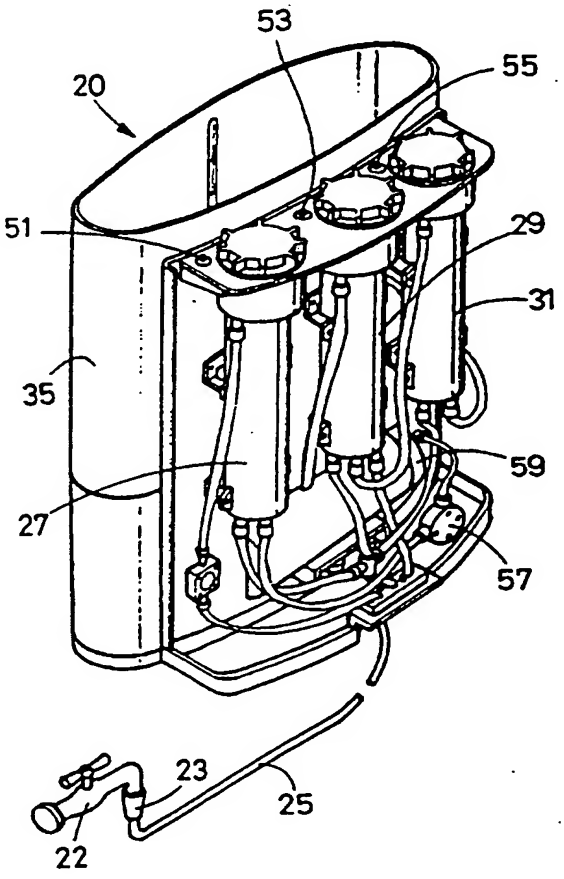

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FIG. 1
(PRIOR ART)

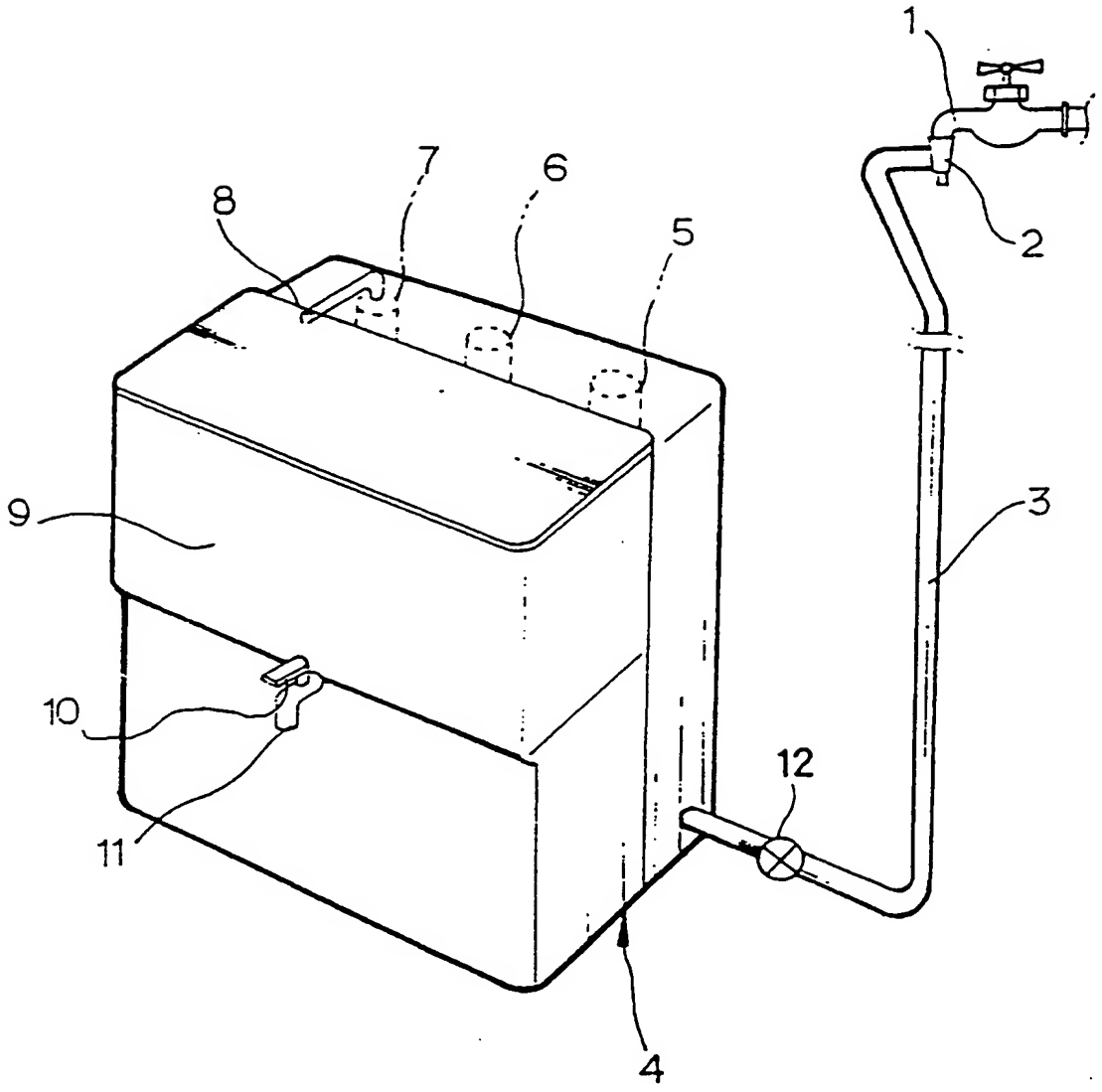


FIG. 2
(PRIOR ART)

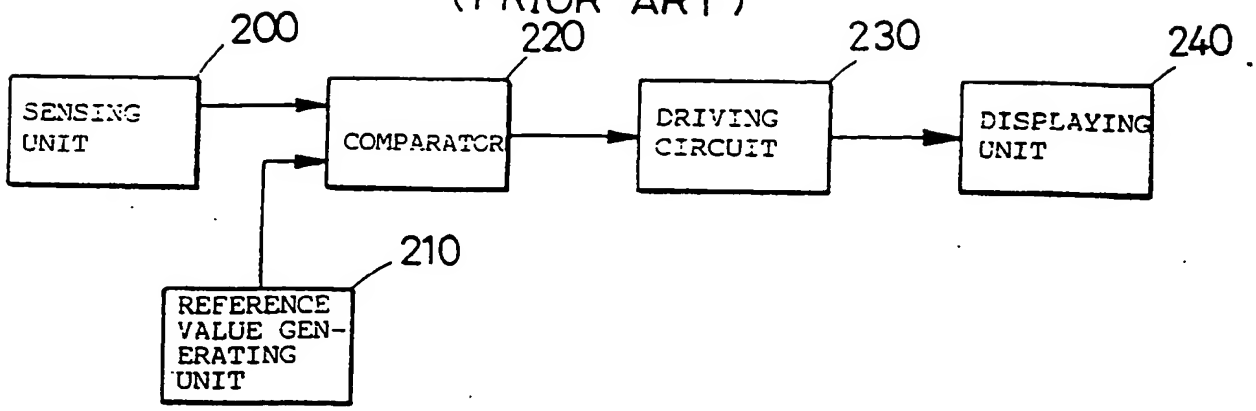


FIG. 3
(PRIOR ART)

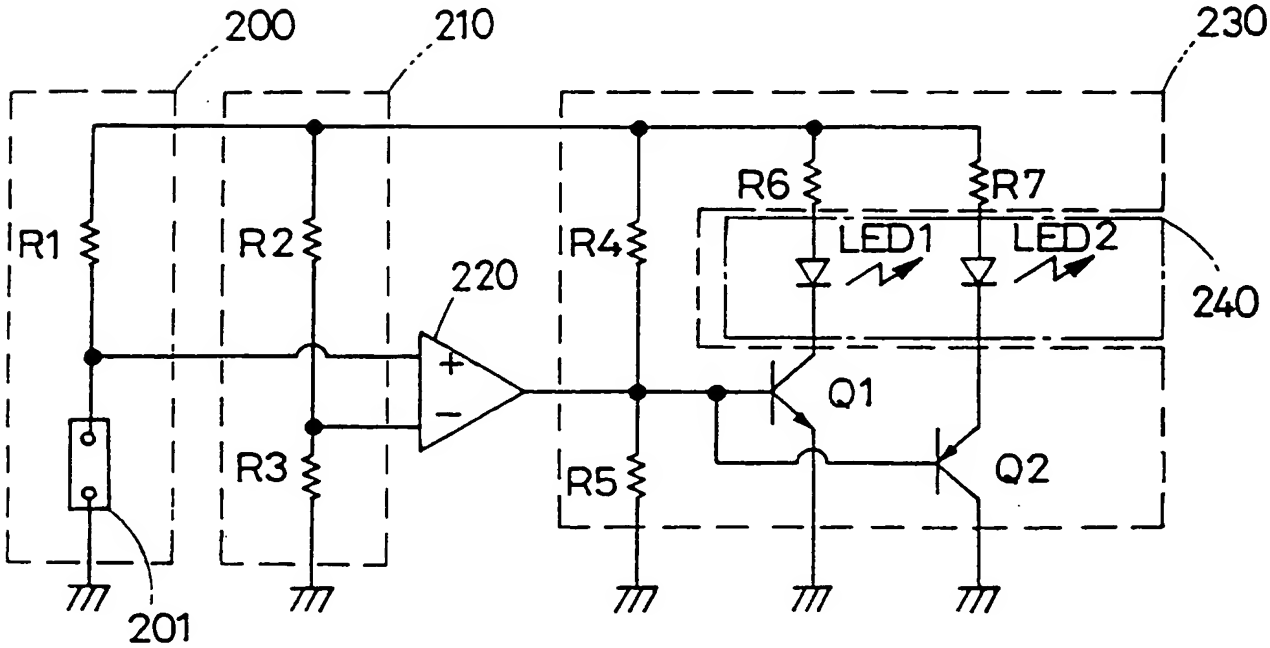


FIG. 4

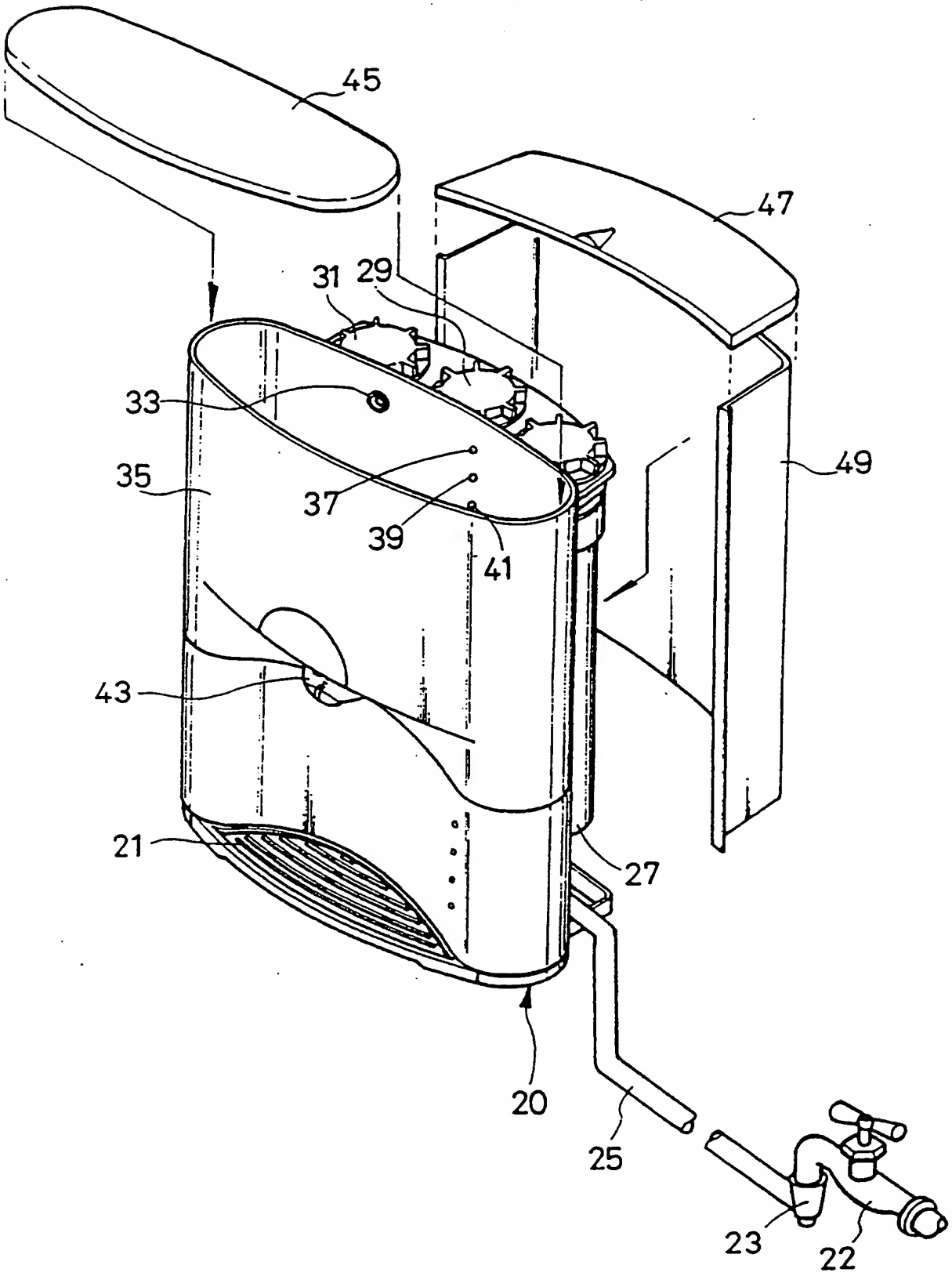


FIG. 5

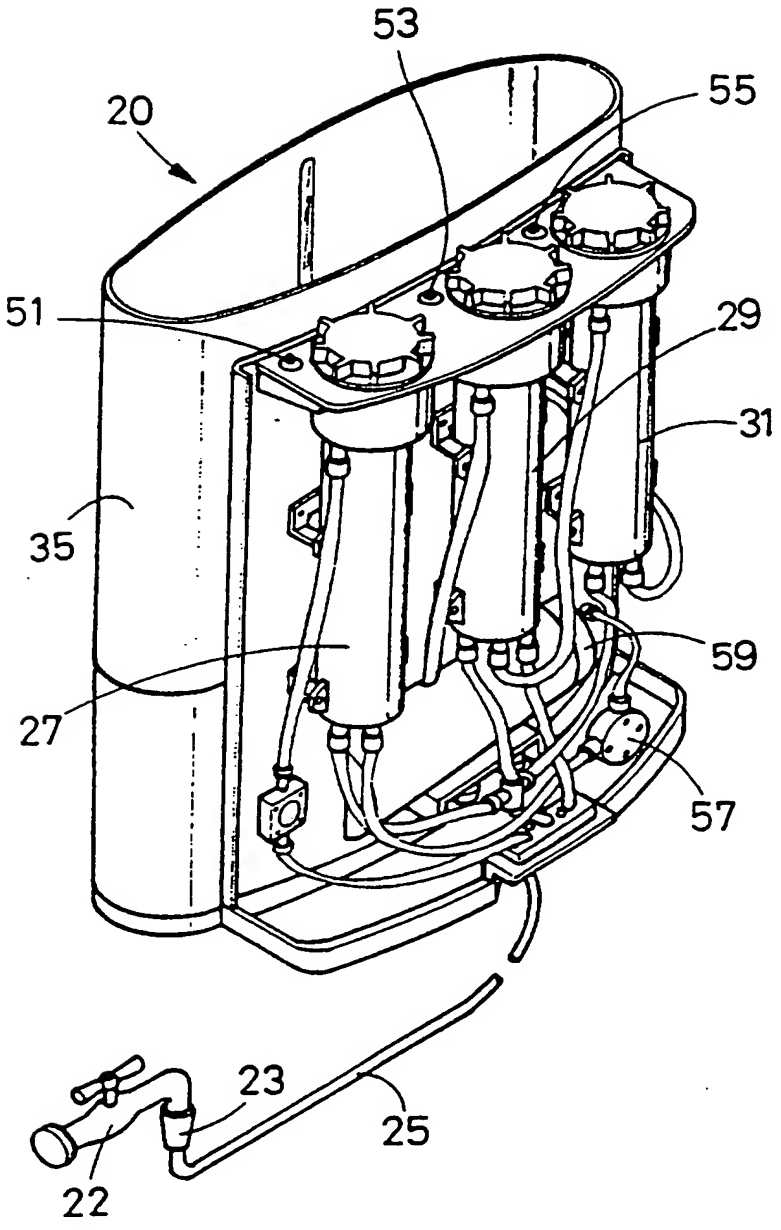


FIG. 6

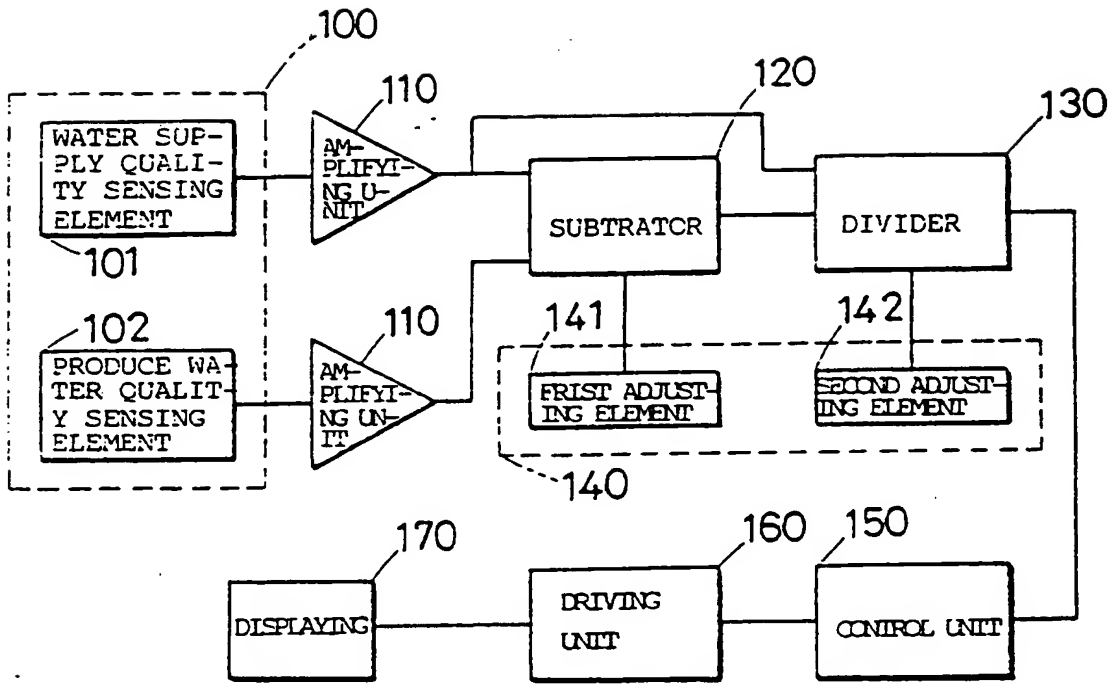
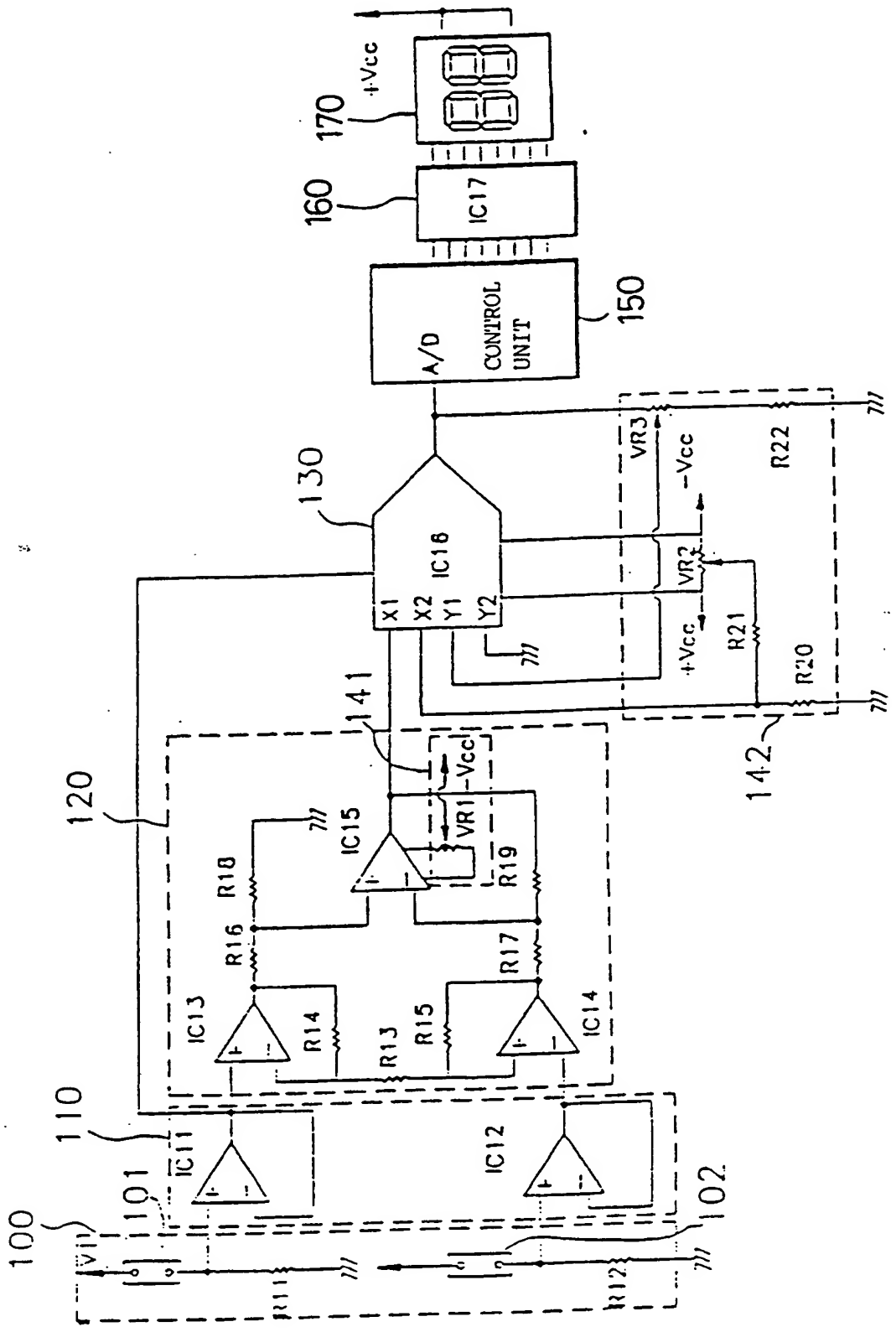

100
110
120
130
WATER SUPPLY QUALITY SENSING ELEMENT
101
AMPLIFYING UNIT
SUBTRATOR
DIVIDER
102
PRODUCE WATER QUALITY SENSING ELEMENT
110
AMPLIFYING UNIT
141
142
FRIST ADJUSTING ELEMENT
SECOND ADJUSTING ELEMENT
140
170
160
150
DISPLAYING
DRIVING UNIT
CONTROL UNIT

FIG. 7


100
101
102
110
120
130
141
142
150
160
170
IC11
IC12
IC13
IC14
IC15
IC16
IC17
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
VR1
VR2
VR3
+Vcc
-Vcc
A/D
CONTROL UNIT
X1
X2
Y1
Y2

Water Purifier

2312176

The invention relates to a water purifier for removing noxious pollutant substances contained in water, such as tap water.

Typically, water purifiers are used to remove noxious pollutant substances contained in fresh water such as tap water, to provide a supply of purified water. They can be classified into a number of different types: natural filtering type, forced filtering type, ion exchanging resin type and reverse osmotic type, in accordance with the method used to purify water.

Water purifiers of the reverse osmotic type, in which fresh water is forced through an artificial osmotic membrane (reverse osmotic filter) can remove heavy metals, bacteria, cancer-causing materials and the like contained in the water. Reverse osmotic water purifiers can supply pure water containing only dissolved oxygen and they have been used in fields such as super-pioneering scientific industries, medical sciences or cleaning for super-precision electronic elements. Recently, such reverse osmotic water purifiers have been used widely as domestic water purifiers for supplying drinkable water.

Figure 1 illustrates a conventional reverse osmotic water purifier which includes a purifier body 4 that is connected to a faucet 1 via a water supply pipe 3 by means of an adapter 2. The purifier body 4 is supplied with fresh water such as tap water, from the faucet 1 through the water supply pipe 3. The fresh water introduced into the purifier body 4 passes through a pre-processing filter 5 disposed at the rear of the purifier body 4. The pre-processing filter 5 removes various harmful organic chemical materials such as chlorine components and the like from the water. The water emerging from the pre-processing filter 5 then passes through a water supply valve which controls the amount of the water supply. The water from the water supply valve is then introduced into a pressure pump so that it can be pressurised to a certain pressure level. The pressurised water is fed to a membrane filter 6

including a plurality of membranes (not shown). Heavy metals, bacteria, cancer-causing materials and the like are filtered from the water as a result of passing through the membranes. The water emerging from the membrane filter 6 then passes through a post-processing filter 7 by which odorous substances such as noxious gases are removed from the water.

The water, which at this stage has a pleasant taste, because of the removal of odorous substances such as noxious gases by the post-processing filter 7, is then fed to a water tank 9 through a water supply port 8.

When the amount of water contained in the water tank 9 corresponds to the full water level, the supply of purified water to the water tank 9 is shut off, and when the amount of water tank 9 corresponds to the empty water level, the water tank 9 is supplied with purified water. In such a manner, the water tank 9 is always replenished with purified water.

The purified water stored in the water tank 9 is discharged through a discharger port 11 by manipulating a water discharge level 10, for drinking.

The conventional water purifier as described above is also provided with an electrical circuit, as shown in Figures 2 and 3, for detecting the quality of the purified water stored in the water tank 9. The circuit includes sensing means 200 comprising water quality sensing element 201 having an electrical resistance which varies in dependence upon the amount of various electrolytes contained in the purified water, and a resistor R1; reference value generating means 210 having two resistors R2 and R3; a comparator 220 with inverting and non-inverting terminals; and a driving circuit 230, wherein the inverting and non-inverting terminals of the comparator 220 receives an electric reference potential divided by the resistance of the resistor R1 and the varying resistance of said sensing element 201, and the reference electric potential divided by the resistors R2, R3 of the reference value generating means 210, respectively.

When the level of the electric potential input to the non-inverting terminal (+) of the comparator 220 is higher than that of the reference electric potential input to the inverting terminal, the output of the comparator 220 goes to high and then transistor Q1 (npn type) of the driving circuit 230 is turned on, which causes a light emitting diode LED1 of the displaying unit 240 to be activated.

In contrast, when the level of the electric potential input to the non-inverting terminal (+) of the comparator 220 is lower than that of the reference electric potential input to the inverting terminal (-) of said comparator, the output of the comparator 220 goes to low, and then, in turn, the transistor Q2 (pnp type) of the driving circuit 230 is turned on, thereby causing LED2 of the displaying unit 240 to be activated.

The circuit thus determines whether the purified state of the water is acceptable or not. Since contaminants in the water cause an increase in electrical conductivity, impure water causes the output of the comparator 220 to become low, thereby turning on LED2. When the purified state of the water is acceptable, the output of the comparator 220 becomes high, thereby turning on LED1. The state of either LED1 or LED2 indicates whether the purified state of the water is acceptable or not.

As can be seen from the above conventional approach, the display only indicates whether the purified state is acceptable or not. Therefore, it is not possible to determine the detailed quality levels of the purified water. Because the user does not know when the filters should be exchanged for new ones, reliability for the filters is degraded.

Therefore it is an object to provide an apparatus for displaying a purifying efficiency of a water purifier which displays the purifying efficiency indicating what amounts of noxious pollutant substances are filtered through the filters, based upon the measurements of pollutant substances in the supplied water

and the purified water, and allows the user to identify the time when the filters should be exchanges for new ones.

Broadly stated the invention provides a water purifier comprising filtering means for purifying water with a variable purifying efficiency, first sensing means for sensing the purity of water to be filtered by the filtering means, second sensing means for sensing the purity of water after being filtered by the filtering means, and purifying efficiency determining means responsive to the first and second sensing means for producing a signal corresponding to the purifying efficiency of the filtering means.

The invention also includes an apparatus for displaying a purifying efficiency of the water purified in which the water purifier including a pre-processing filter, a membraned filter, a post-processing filter, and a water tank that stores the purified water by passing through said filters comprises a supply water quality sensing element for sensing the amount of pollutant substances contained in the supplied fresh water; a produced water quality sensing element for sensing the amount of pollutant substances contained in the purified water through said filters; amplifying means for amplifying weak signals sensed by the sensors; a subtractor for receiving the signals obtained from the respective amplifying means and deriving the difference between the amplified signals; a divider for dividing the output signal from the subtractor by the sensed and amplified signal from the supply water quality sending element; adjusting means for adjusting erroneous values to obtain the correct results of said subtractor and divider; control means for deriving the purifying efficiency based upon the signal output from the divider and, from the above derived result, outputting signal indicating the purifying efficiency and the purified state; and displaying means for receiving the output signal from the control means via a driving circuit and displaying the purifying efficiency and the purified state.

Features and advantages of the invention will become apparent from the

following description of an embodiment thereof, given by way of example with reference to the accompanying drawings in which:

Figure 1 is a perspective view illustrating the overall construction of a conventional water purifier;

Figure 2 is a block diagram illustrating a water quality sensing circuit of a conventional water purifier;

Figure 3 is a more detailed circuit diagram of a water quality sensing circuit shown in Figure 2;

Figure 4 is an exploded perspective view of a water purifier according to an embodiment of the present invention;

Figure 5 is a rear perspective view of the water purifier shown in Figure 4;

Figure 6 is a block diagram of an apparatus for displaying the purifying efficiency of the water purifier according to an embodiment of the present invention; and

Figure 7 is a detailed circuit diagram of the apparatus shown in Figure 6.

In Figure 4, a water purifier according to the invention has a body 20 which is provided at its front with a receiving portion 21 for receiving a water receptacle such as a cup.

A water supply pipe 25 is connected at one end to the purifier body 20 at its rear. The other end of the water supply pipe 25 is connected to a faucet 22 by means of a connecting member 23. A pre-processing filter 27 in the purifier body 20 is connected to the water supply pipe 25 and is configured to remove various harmful organic chemical substances such as chlorine components and the like from fresh water supplied from the faucet 22.

A membrane filter 29 is disposed to one side of the pre-processing filter 27, which includes a plurality of membranes (not shown) serving to remove heavy metals, bacteria, cancer-causing materials and the like contained in the water emerging from the pre-processing filter 27. A post-processing filter 31 is connected to the membrane filter 29 to remove odorous substances, such a

noxious gas, contained in the water emerging from the membrane filter 29.

A water tank 35 is separably seated on the purifier body 20. The water tank 35 has a water inlet port 33 for water purified by the post-processing filter 31. The water tank 35 is also provided on its inner rear surface with sensing electrodes of a pair of water level sensors 37 and 39 respectively adapted to sense different amounts of purified water stored in the water tank 35 corresponding to the full and empty water levels.

A water discharge lever 43 is disposed on the front exterior surface of the water tank 35, to discharge the purified water stored in the water tank 35 through a water discharge port (not shown). The top of the water tank 35 is covered by an upper cover 45. The purifier body 20 is enclosed by a side cover 49 and a top cover 47.

In Figure 4 reference numeral 41 denotes sensing electrodes for the pair of water level sensors 37 and 39.

As shown in Figure 5, on upper end of the pre-processing filter 27, the membrane 29 and the post-processing filter 31 are provided with a respective reset switch 51, 53 and 55 for resetting the time period permitted to be used for each of the filters, at the time when the pre-processing filter 27, the membrane 29 and the post-processing filter 31 are to be exchanged with replacements.

A water supply valve 57 is connected between the post-processing filter 31 and the water tank 35, as shown in Figure 5. The water supply valve 57 is opened and closed in accordance with the amount of purified water contained in the water tank 35, namely, the level of water in the tank 35. A pressure pump 59 is connected between the pre-processing filter 27 and the membrane filter 29 to apply pressure to the water emerging from the pre-processing filter 27, thereby feeding the water to the membrane filter 29 at a sufficient pressure for

it to be purified by the membrane filter 29 by reverse osmosis.

The circuit for displaying the purifying efficiency of the water purifier will be described in detail with reference to Figure 6 and Figure 7.

Referring to Figure 6, the circuit comprises water quality sensing means 100 having a water supply quality sensing element 101 for sensing the amount of pollutant substances contained in the supplied fresh water, and a produced water quality sensing element 102 for sensing the amount of pollutant substances contained in the purified water; a pair of amplifying means 110 for amplifying weak signals from the water quality sensing means 100; a subtractor 120 for receiving the signals obtained from the amplifying means and deriving the difference between them; a divider 130 for dividing the output signal from the subtractor 120 by the sensed and amplified signal from the amplifying means 110 for ratio calculations explained in more detail hereinafter; adjusting means 140 having a first adjusting element 141 and a second adjusting element 142, wherein the output signals are adjusted to obtain desired correct results form the subtractor 120 and divider 130; a microcomputer (hereinafter, referred to as a control means) 150 for deriving the purifying efficiency based upon the signal output from the divider 130 and, based on the result, outputting a signal corresponding to the purifying efficiency of the purifier and the purified state of the water; and a driving circuit 160 for sending the output signal from the control means 150 to a digital displaying means 170.

Referring to Figure 7, this illustrates the circuit in more detail. A coupling point between the water supply quality sensing element 101 and a resistor R11 having one end grounded, is connected to a non-inverting terminal of amplifier IC11 of the amplifying means 110. Another coupling point between the produced water quality sensing element 102 and a resistor R12 having one end grounded, is connected to a non-inverting terminal of amplifier IC12 in the amplifying means 110.

The output of IC11 is coupled into a non-inverting terminal of amplifier IC13 in the subtractor 120, and the output of IC12 is coupled to an inverting terminal of amplifier IC13. The outputs of IC13 and the IC14 are connected to respective non-inverting and inverting inputs of an amplifier IC15 which has its output connected to one input terminal X1 of IC16 which functions as the divider 130. The output of IC11 is also connected to IC16.

The first adjusting element 141 which is connected to IC15 in the subtractor 120, comprises a variable resistor VR1 for performing a fine adjustment to obtain a correct result from IC15. Similarly, the second adjusting element 142 which is connected to IC16 in the divider 130, comprises a variable resistor VR3 for performing a fine adjustment to obtain correct data from IC16.

The divider 130 receives both the output of IC11 and the output of IC15 of the subtractor 120 and performs a division of one by the other. The result of the division is applied to the input terminal A/D of the control means 150, which analyses the signal input thereto outputs the analysed result to IC17 of the drive circuit 160. Then, IC17 sends the signals output from the control means 150 to the displaying means 170 for displaying the finals results.

The reference symbols R13 to R22 and Vcc denote resistors and a power supply, respectively.

The water purifier is configured to be connected to a commercial AC power, which is converted by a AC/DC converter (not shown) into a DC voltage with a low voltage level suitable for driving the water purifier. Thus, the application of DC voltage activates the respective driving circuits and the control means 150, which enables the water purifier to initialise its circuits.

The amount of water stored in the water tank 35 is sensed as a varying output voltage depending upon the water level, by means of the sensors 37 and 39. The control means 150 executes the comparison of the output voltages of the

full and empty water sensors 37, 39 and a predetermined reference voltage. Then, the control means 150 determines whether the amount of water stored in the water tank 35 is at the empty water level or not, and controls the water inlet supply so as to maintain the level of the water amount in the water tank 35 between the levels defined by the sensors 37 and 39.

When the water level of the water tank 35 is determined as being higher than the empty water level, the purifying operation is not required until the water level goes to below the empty water level.

However, when the water level in the water tank 35 goes below the empty water level, the control means 150 causes the water supply valve 57 to be opened so as to supply purified water to the tank.

Once the water supply valve 57 has been opened, fresh water such as tap water, begins to be fed into the water supply pipe 25 through the connecting member 23 from the faucet 22. The control means 150 drives the pressure pump 59 so that the pressure of fresh water fed through the water supply pipe 25 and into the membrane 29, reaches a predetermined level.

The activated pressure pump 59 opens the water supply valve 57, thereby enabling fresh water from the faucet 22 to pass from the supply pipe 25 through the pre-processing filter 27, which results in the removal of various noxious pollutant substances such as chlorine components . Water from the above pre-processing filter 27 is supplied to the membrane filter 29 through the water supply valve 57.

The water from the pre-processing filter 27 is then introduced into the membrane filter 29 through the water supply valve 51 while being increased in pressure to a certain pressure by the pressure pump 59. On passing through the membrane of the membrane filter 29, the water become free of heavy metals, bacteria, cancer-causing materials and the like contained therein.

The water emerging from the membrane filter 29 then passes through the post-processing filter 31 by which odorous substances such as noxious gas are removed from the water. The water from the post-processing filter 31 is then supplied to the water tank 35 through the water inlet port 33.

When the water level of the water tank 35 sensed by the full and empty water level sensors 37 and 39 corresponds to the full water level, the control means 150 shuts off the water supply valve 57 and stops the operation of the pressure pump 59.

The purity of the water entering the purifier is detected by the sensor 101, and the purity of the water after having been filtered by the filters 27, 29 and 31 is detected by the sensor 102.

The small amplitude signals from the sensors 101 and 102 are, respectively, applied to IC11 and IC12 of the amplifying means 110, and amplified. Then the amplified signals are provided to the subtractor 120, namely IC13, IC14 and IC15, in which the following calculation is performed.

In the following analysis, the symbols A, B and C represent data corresponding to the quality of the supply water fed into the water purifier, the quality of the water produced after filtration through the filters 27, 29 and 31, and the output result from the subtractor 120. The operation of the subtractor 120 yields the result C by subtracting B from A.

However, in order to calculate the ratio of the removal of noxious pollutant substances of the produced water to the supply water supplied from the water purifier, it is required to divide the result C (from the subtractor 120 in accordance with the equation C = A - B) into the data for the quality of the supply water used in the previous calculation. The divider 130, namely IC16 functions to calculate the parameter D, D = C/A (where D represents the division result).

It will be understood that the parameter D is a measure of the purifying efficiency of the filters 27, 29, 31 in the purifier.

In the above described processing, the first adjusting element 141 may be adjusted to obtain the correct result from the subtractor 120, through fine adjustment of the variable resistor VR1. The fine adjustment for obtaining the correct data from the divider 130 is through the second adjusting element 142 made up of variable resistors VR2, VR3.

The resulting signal from the divider 130, which is an analogue signal, is applied to the input terminal A/D of the control means 150, which provides a corresponding digital output to the driving circuit 160 comprising IC17, which drives displaying means 170, such a 7-segment device, so as to display the purifying efficiency.

A user can determine from the display whether the filters in the water purifier are required to be exchanged or not. The user compares the displayed data D with a predetermined value for the exchange of the filters. The user changes the filters in the event that the displayed value is less than the predetermined value.

The control means 150 controls multiple tasks, namely the display of the purifying efficiency through the displaying means 170, and the opening of a valve (not shown) for discharging the purified water in the water tank 35. The control means 150 may also drive the displaying means 170 to display whether the water in the tank 35 is drinkable or not.

As described above, the present invention has the advantage that the purity of the supplied water and the purified water can be measured and accordingly a measure of the purifying efficiency can be provided which allows the user to determine whether the filters need to be exchanged, based on the displayed purifying efficiency.

Whilst in the described example, the purifying efficiency is determined based on the parameter D, it will be understood that other purifying efficiency definitions could be utilised, based on other predetermined relationships between the measured purity of water entering the filters and leaving the filters after filtration.

Claims

1 A water purifier comprising filtering means for purifying water with a variable purifying efficiency, first sensing means for sensing the purity of water to be filtered by the filtering means, second sensing means for sensing the purity of water after being filtered by the filtering means, and purifying efficiency determining means responsive to the first and second sensing means for producing a signal corresponding to the purifying efficiency of the filtering means.

2 A water purifier according to claim 1 including display means for displaying the purifying efficiency in dependence upon the value of the signal.

3 A water purifier according to claim 1 or 2 wherein the first and second sensing means are operative to produce first and second electrical signals corresponding to the purity of the water entering and leaving the filtering means respectively, and the purifying efficiency determining means is operative to produce said signal corresponding to the purifying efficiency of the filtering means as a function of a ratio of the difference between the first and second electrical signals, and the first electrical signal.

4 A water purifier according to any preceding claim wherein the filtering means includes a reverse osmotic filter, a pre-processing filter for water before it enters the reverse osmotic filter, and a post-processing filter for water leaving the reverse osmotic filter.

5 A water purifier according to any preceding claim including control means responsive to said signal corresponding to the purifying efficiency of the filtering means for producing a digital signal corresponding thereto.

6 A water purifier according to claim 5 wherein said control means is additionally operable to perform other control functions for the purifier.

7 An apparatus for displaying the purifying efficiency of a water purifier comprising a pre-processing filter, a membraned filter, a post-processing filter, and a water tank for storing the purified water passing through said filters to which fresh water has been supplied comprising:

a supply water quality sensing element for sensing the amount of pollutant substances contained in the supplied fresh water;

a produced water quality sensing element for sensing the amount of pollutant substances contained in the purified water passing through said filters;

amplifying means for amplifying weak signals sensed by said sensors;

a subtractor for receiving the signals obtained from the amplifying means and deriving the difference between the amplified signals;

a divider for dividing the output signals from the subtractor by the sensed and amplified signal from the supply water quality sensing element;

adjusting means for adjusting erroneous values to obtain the correct results of said subtractor and said divider;

control means for deriving the purifying efficiency based upon the signal output from the divider and, from the above derived result, outputting signal indicating the purifying efficiency and the purified state of the water; and

displaying means for receiving the output signal from the control means via a driving circuit and displaying the purifying efficiency and the purified state.

8 An apparatus as claimed in claim 7, wherein the supply water quality sensing element and the produced water quality sensing element include two sensing rods of metal for sensing flows of electric current between the rods to measure amounts of pollutant substances containing the supplied water and the purified water.

9 An apparatus as claimed in claim 7 or 8, wherein the amplifying means includes IC11 for amplifying the sensed signal by the supply water quality sending element; and IC12 for amplifying the sensed signal by the produced water quality sensing element.

10 An apparatus as claimed in claim 7, 8 or 9, wherein the subtractor includes IC13 for receiving the amplified signal for supply water quality sensing element; and IC15 for receiving the signals output from the IC13 and the IC14.

11 An apparatus as claimed in claim 7, 8, 9 or 10, wherein the control means controls to discharge the contaminated water in the water tank in accordance with the output signal from the divider.

12 An apparatus as claimed in claim 7, wherein the displaying means is adapted to display the information indicating whether the water is drinkable, not to drink the contaminated water in the water tank, according to the control means.

13 A method for replacing the filtering means in a water purifier according to any one of claims 1 to 6, including determining when the purifying efficiency signal falls below a threshold value of purifying efficiency, and then replacing the filtering means.

14 A water purifier substantially as hereinbefore described with reference to Figures 4 to 7 of the accompanying drawings.

The Patent Office

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Claims searched: 1-6, 13, 14

Examiner: Peter Emerson
Date of search: 15 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B1D DNFC, B1T TNFC, B1X

Int Cl (Ed.6): B01D 35/14, 35/143

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 5450744 A (SENSON) - whole document.	1, 2, 4, 13
X	US 3502970 A (THAYER) - see col. 1 lines 55 - 65.	1, 2, 4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.